Fieldable Microsystems II (FMII)

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LONG-TERM GOALS

The overall goal of this work involves the development of self contained, fieldable micro sensors fabricated with micromachining technology. The targeted integrated sensor comprises a microanalytical segment, integrated detection electronics and associated telemetry functionality for both a chemical sensor (explosive detection) and physical sensor (CTD).

OBJECTIVES

The main focus of the effort is to advance the design, fabrication and field testing of a microfluidic device as an adaptive chemical analyzer that utilizes on-chip reaction separation and either a photonic or an electrochemical detection strategy. The implementation of two different fluid-flow pump mechanisms and the use of hybrid packaging for electronic integration are a portion of the development effort. The scope of work included multiple developments: field deploy a separations device; advance seawater sampling preconcentration, devise an integrated opto chip; develop chip HPLC that includes a mini high-pressure pump and mini power supply; place temperature and conductivity and depth functions on a planar surface and develop sensor packaging techniques.

APPROACH

As in the past we rely on the advances in our non standard MEMS fabrication methods that we have developed for ease of creation of the MEMS and to further the microsensors for the field. The microfluidic chemical separations sensor has two main paths of development: ship board CE system and mini HPLC field sensor. Method development for seawater matrices is a necessary task for all field analysis. The current project includes the transfer of the lab based chemical processor for deployment in the field along with advancing the CTD physical sensor.

WORK COMPLETED

Shipboard CE system

We have a completed lab system and have focused effort on the one technical obstacle left for shipboard deployment for protein distribution measurements: protein purification. We have developed a temperature sensitive hydrogel based approach for the separation. Figure 1 shows the results from

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14. ABSTRACT
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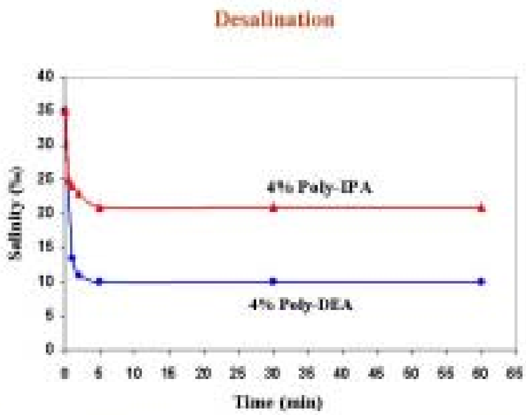
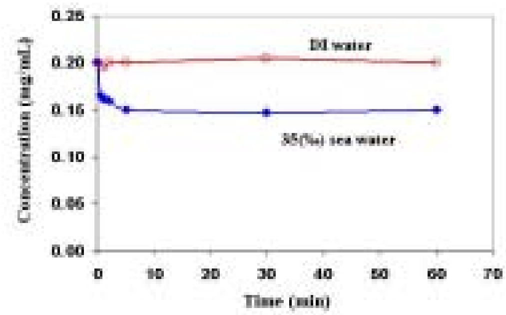
our “smart” hydrogel   Simplified extractions for protein preconcentration from seawater for field use have been difficult to achieve. Effort on the protein purification process is continuing.



Time course of desalination using temperature-sensitive hydrogels.



Dilution of protein solution (albumin, chicken egg) due to release of water from swelled 4% poly-IPA.

Figure 1. Protein purification results from temperature sensitive hydrogel for sample prep of seawater.

HPLC- pump

For the HPLC version system we have continued progress on the high pressure fluid micropump. We have tested the concept and we have fabricated onchip patterned explosive material. We have tested and moved fluids from one fluidic chamber to a separate chamber as proof of fluid control.

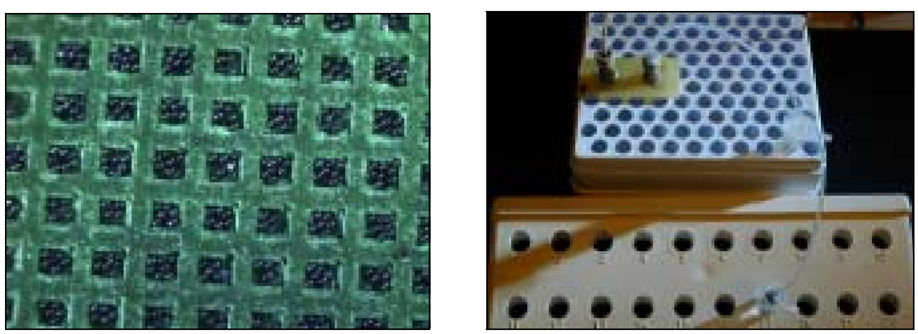


Figure 2. Explosive powder in microwell array (left). Fluid transfer test bed that resulted in complete transfer of fluid in upper chamber to lower chamber from overpressurization provided by explosive source in upper left corner of image.

Micro Power Generation

We have also made progress on the final design of the fluidic-based power supply and have generated power using a mini coil and 25 psi source.

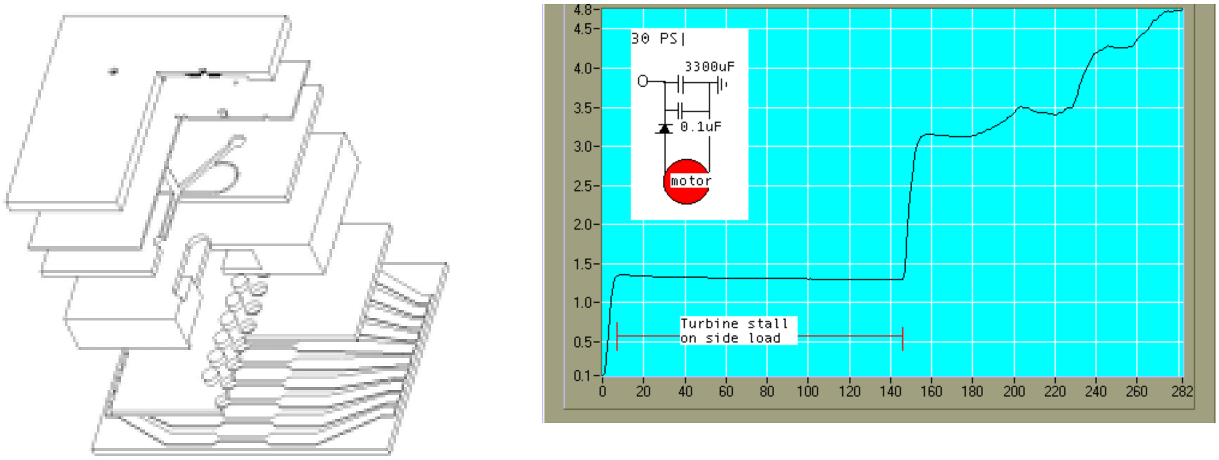


Figure 3. Fluid pressure- mechanical to electric generator design (left). Four volts generated using fluid pressure and mini coil and circuit listed.

Opto-electronic cube.

The compact LED/PD based opto-analyzer has made progress. We have a designed and are testing a disposable cube analyzer for explosives residues and other environmental targets using embedded solid phase extraction. Our approach is to use these detectors coupled tightly with AUV's for a robotic chemical screening. We are focusing our efforts to include the mini-system on the Ranger mini-AUV from Nekton Research.

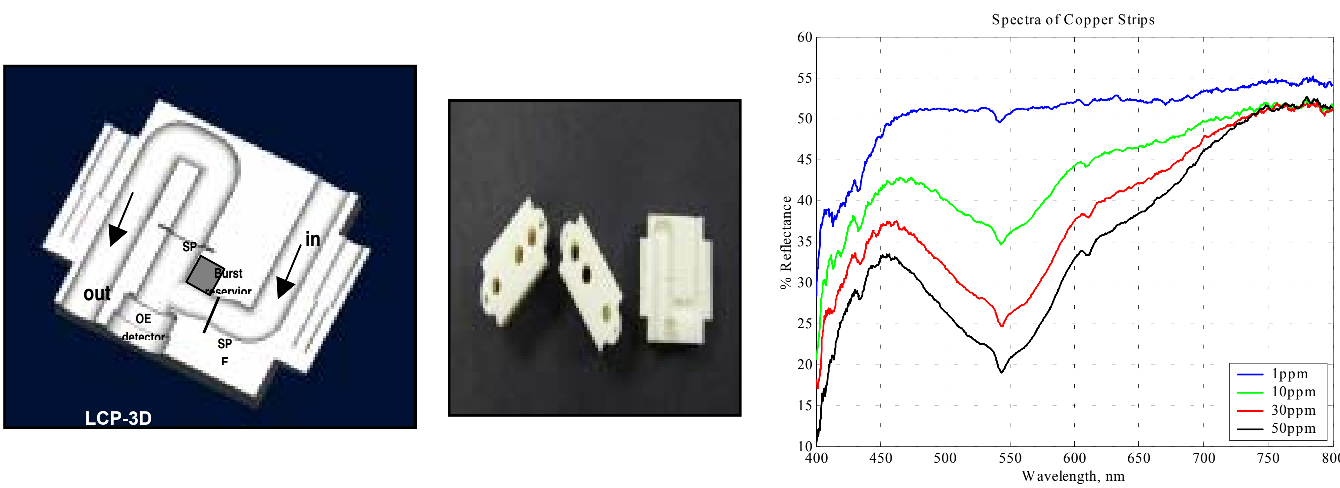


Figure 4. Robotic Chem Sensor design (left). Fabricated prototype (center). Results from Cu sensitive solid phase material. Decreased reflectance signal from the strip with increasing sample concentration and/or increasing volume sampled.

Electrochemical Detection system/nose

We have made continued progress for the electrochemical detection mode of the CE device and pressure driven devices through our partnership with Dr Wang (NMSU) with a focus on explosives detection. In order to make a fieldable system we have expedited the deployment of the three-electrode voltammetric remote sensor. The probe has proven results for seawater analysis for explosives. We are in process of making a submersible system for 4th quarter deployment.

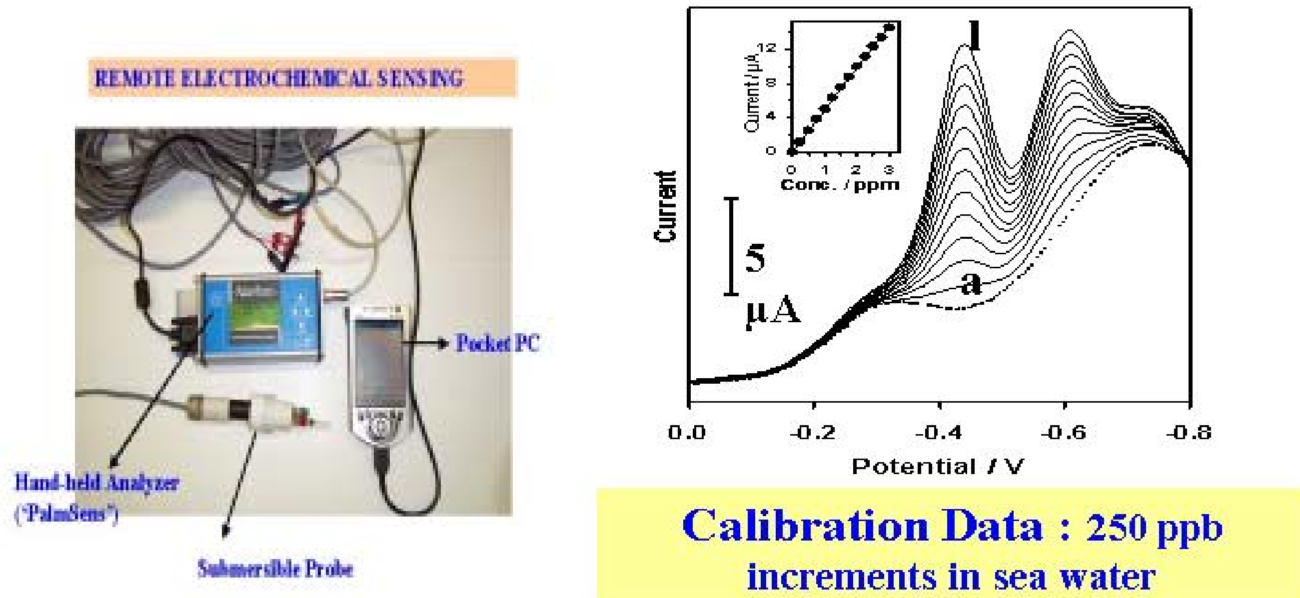


Figure 5. Remote voltammetric sensor system (left).
Explosive residues data from the lab system. MicroCTD

We have used the previous progress on the torioidal conductivity sensor formed in multi-layer PCB substrates as the design basis for the entire CTD system. We have focused much of our effort on liquid crystal polymer (LCP) for creating this PCBMEMS system due to its superior water resistance and the process steps for processing the LCP material.

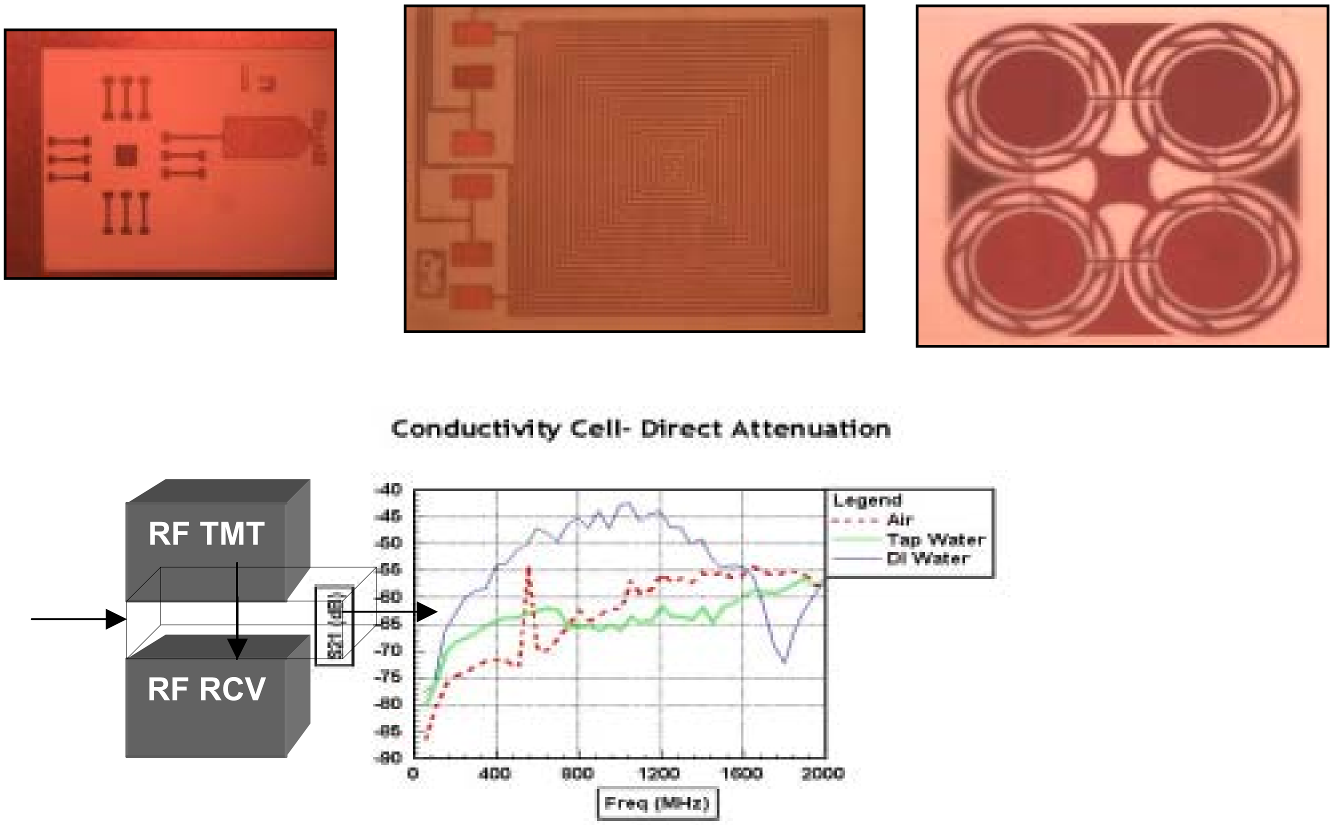


Figure 6. C,T,D sensors fabricated in LCPMEMS fabrication process (above, left to right). Results from conductivity measurements of a laminated cell in a direct RF measurement mode. This mode has a small channel between the coils (left) and a direct attenuation measurement is made (right).

Integrated microchip Ionsprayer

We have focused on the microchip ion sprayer towards modeling and understanding a direct introduction liquid sprayer with integrated ion lensing. Next steps are the fabrication of the chip using our developed LCPMEMS fabrication process for fluidics, sprayer and integrated lens system.

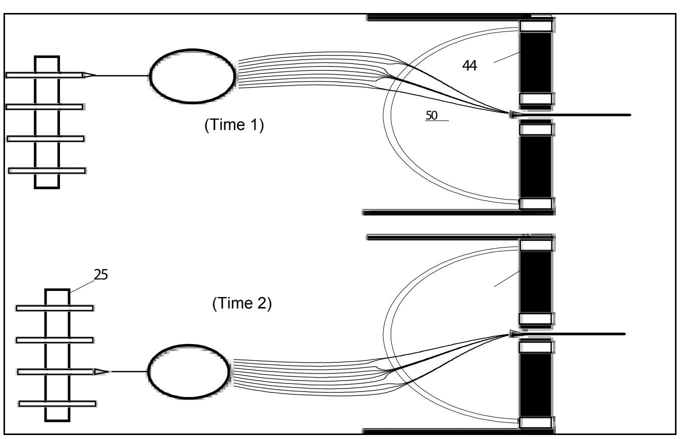


Figure 7. SIMION modeling of a spray chip with hemispherical laminated lens system focusing ions into a detector aperture showing increased compression of the sprayed ions from tip array (at left).

Sensor Array Packaging

Also included in the project is the creation of a system in a package approach towards integrated marine microsensors. We have proceeded with a folded flex system in a package approach and are currently in design and fabrication efforts with Tessera Inc.

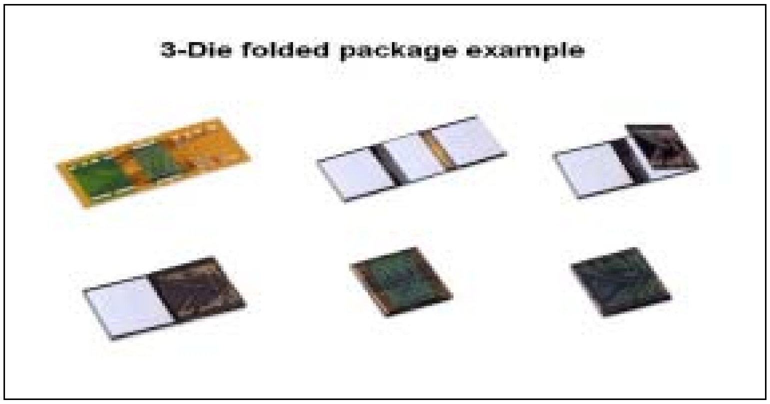


Figure 8. Folded flex system in package approach for the microdatalogger portion of the integrated fieldable microsystem.

RESULTS

We have contributed to advances in the field of Maritime MEMS and the techniques needed to fabricate microfluidic-based systems for field analytical purposes. We have intiated primary work in the development of PCBMEMS, an emerging field. This project has encountered expected difficulting in transferring lab techniwues into the field. Our current focus is to push integration of the explosive lab prototypes into the field for homeland security support.

IMPACT/APPLICATIONS

This proof of technology demonstration has impact for both marine science and ocean systems applications as a design and development paradigm that can allow the creation of inexpensive microsensors. Ocean Observing Systems, Operational Oceanography and Homeland Security will benefit from the new manufacturing and technology approach.

TRANSITIONS

We expect this technology practice to emerge as the global ocean observing efforts emerge and large sensor arrays and sensor grids are implemented.

RELATED PROJECTS

We are involved in another (SMDC-ARMY) project aimed at a field sensor for terrestrial monitoring applications.

PATENTS, PUBLICATIONS, TECHNOLOGY TRANSFER

Fries, D.P., Steimle, G., Broadbent, H., Natarajan, S., Weller, T., Maskless Lithographic PCB/Laminate MEMS for a Salinity Sensing System, Intl. Soc . Packaging and Microelectronics, Adv. Tech Workshop, Sept 2002, Denver, CO

Fries, D.P., Securing Harbor Systems, SeaMIST: Sea Micro Integrated Systems Technology, COMMS Comm. MicroSystems Symposium 2002, Sept. 2002, Ypsilanti, MI